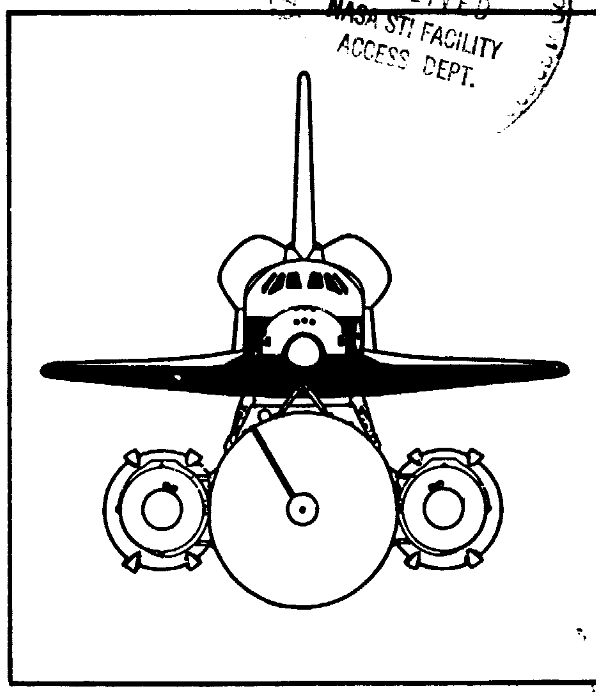
NASA Educational Briefs

An Educational Publication of the National Aeronautics and Space Administration

For the classroom



Shuttle's Fourth Test Flight

The Space Shuttle has now become an operational space launch system. On July 4, 1982, the Shuttle Orbiter Columbia returned from its fourth test flight in space and landed at the NASA Dryden Flight Research Facility at Edwards, California. Riding Columbia for 169 hours and 112 orbits of the Earth were Thomas K. (Ken) Mattingly and Henry W. Hartsfield. Mattingly, the commander of STS-4, is an experienced astronaut, having been the command module pilot of Apollo 16. Hartsfield, STS-4 pilot, has been a NASA astronaut for a number of years but this was his first spaceflight.

When Columbia and its crew began its on-time flight on June 27, 1982 its principal objectives were to continue the step-by-step evaluation of the Space Shuttle's air worthiness and the compatability of Shuttle components with each other and ground support facilities. The nearly perfect launch was only marred by the loss of the two solid rocket boosters. The parachute systems on both boosters failed and both sank in the Atlantic ocean after jarring impacts with the water.

In orbit, more tests were conducted on the thermal characteristics of the Orbiter. These tests continued the thermal testing program of STS-3 a few months before. Evaluation of the Orbiter's research environment was also continued from earlier missions. The Orbiter's remote manipulator system arm (RMS) was successfully tested again with deployment of a more massive payload than was "waved" above the cargo bay on STS-3. A Department of Defense payload and many new science experiments were carried on board Columbia, including two high school student experiments and nine college student experiments. Several other science experiments were carried that had also flown on earlier missions. On reentry and landing, more aerodynamic tests of the Orbiter's flight characteristics were conducted including landing on a concrete runway.

Induced Environment Contamination Monitor

Carried twice before into space by Columbia, the Induced Environment Contamination Monitor experiment (IECM) continued the study of the environmental characteristics of the Shuttle cargo bay and near space. On this mission, the IECM took the form of a 363 kilogram, deck-sized package. During testing, it was lifted out of the cargo bay by the remote manipulator arm "waved" about various locations of the Orbiter. During this maneuver, the IECM measured pressure waves produced by firing reaction control rockets in the Orbiter's nose. Tests performed by the IECM include gas and particulate sampling, humidity measurement, and investigating the optical effects of contamination. Information gained by the eleven instruments on the IECM will help determine what environmental hazards exist for future delicate scientific instruments and develop baseline environmental parameters of the Shuttle for future research.

EB 82-5

(NASA-EB-82-5) NASA EDUCATIONAL BRIEFS FOR THE CLASSROOM. SHUTTLE'S FOURTH TEST FLIGHT (National Aeronautics and Space Administration) 4 p HC A02/MF A01 CSCL 22A

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Monodisperse Latex Reactor

On the third flight of Columbia, the production of monodisperse (identical size) polystyrene latex microspheres was studied in the weightless condition of Earth orbit. Latex spheres have important medical applications in measuring pore sizes in the human eye in glaucoma research and as carriers for drugs and isotopes in treatment of cancerous tumors. This experiment was one of two material processing studies carried on STS-4.

To make monodisperse latex spheres, a latex mixture was heated in order to initiate a chemical reaction that begins the sphere formation. To assist in the growth, spheres grown on the earlier mission were used as seeds.

The object of the experiment was to learn if spheres larger than twenty microns in diameter could be grown in weightlessness. Spheres grown on Earth reach a maximum size of about three microns. On STS-3 they grew to a maximum of about five microns. During the STS-4 experiment, spheres grew up to 10 microns in size.

Plans are underway to use the STS-4 spheres as seeds for future Shuttle flight experiments on monodisperse latex sphere growth.

Nighttime/Daytime Optical Survey of Lightning

Due to system problems on the second flight of Columbia, that shortened the mission, the first version of Nighttime/Daytime Optical Survey of Lightning experiment had insufficient operation time in space to obtain meaningful results. The survey had hoped to obtain a space-eye view of lightning flashes in order to gain some insight into the evolution of lightning in storms.

On the fourth Shuttle flight the lightning study was conducted again. Using a 16 mm data acquisition camera synchronized with a two-channel stereo cassette recorder, astronaut Mattingly and Hartsfield were able to record lightning displays. Because of Columbia's altitude above Earth, severe storms were visible on nearly every orbit. To help the crew prepare for monitoring storms, weather watchers at the NASA Marshall Space Flight Center identified potential severe storm zones under the path of the Orbiter and alerted the crew to be ready. During daytime passes, crewmembers identified storms by observing cumulonimbus cloud build ups and during nighttime passes identified storms by watching for the visible flashes of lightning.

Special emphasis in this investigation was placed upon observing lightning at night. A diffraction grating was placed over the camera's lens and spectrographs of lightning strokes were recorded. From the spectrographs, researchers are now calculating temperature, pressure, molecular species, electron density, and percent of ionization in the lightning's path.

Continuous Flow Electrophoresis System

Nicknamed "Eos" (Greek god of the dawn), the Continuous Flow Electrophoresis System is the first use of the Space Shuttle by a commercial concern. The experiment is the initial engineering test that is part of a six-flight experiment scheduled over the next two years. In the test, six protein samples were subjected to an electric current to separate out desired components. On Earth, gravitational attraction limits the electrophoresis process and causes convection currents resulting in incomplete separation. Furthermore, to make the process work on Earth, only 0.25 percent of the sample to be separated can be biological material and the remainder must be a carrier fluid. In space, the biological portion of the sample can be increased to 20 percent or more, producing potential yields 80 to 100 times greater than on Earth.

The Eos experiment is part of a joint endeavor between NASA and the McDonnell Douglas Corporation. Collaborating with McDonnell Douglas is the Ortho Pharmaceutical Division of Johnson and Johnson. Under the agreement, NASA and private enterprise work together as partners to promote the utilization of space. From the agreement NASA gains experience in separation sciences and McDonnell Douglas and Johnson and Johnson will gain from any commercial applications resulting from the experiments.

First Getaway Special Payload

Getaway Specials are small self-contained payloads that are packed into trash can-sized canisters and inserted into the cargo bay of the Orbiter. The canisters make efficient use of what would be wasted space between the much larger payloads the Shuttle has to carry. Getaway Specials are available to anyone interested in conducting space research on a first come, first served basis. Through a canister rental agreement, experimenters can orbit payloads of up to 91 kilograms for a cost of $10,000. Smaller payloads can be orbited for as little as $3000. The fee for a Getaway Special is far less than the millions of dollars normally charged for orbiting experiments. The only criteria for the experiment is that it must be scientific or technologic in nature, self-contained, present no safety problems for the Orbiter, and be operable without crew tending.

On STS-4, the first Getaway Special payload was orbited in Columbia's cargo bay. The payload canister was rented by Gilbert Moore and donated to Utah State University where it became the focus of a research and training program for university students. In the 0.14 cubic meter volume of the canister, Utah students packed nine experiments, a data and control center, and power supply. During flight, the crew reported that they were unable to activiate the experiments. The problem was diagnosed to be a broken wire in the command circuit. Using a "hot wiring" technique, the package was finally activated.

Drosophilia Melanogaster (Fruit Fly) Growth Experiment

This experiment is designed to provide a means of raising and separating succeeding generations of fruit flies, Drosophilia Melanogaster, in orbit to study the effects of microgravity on their genetic structure.

Artemia (Brine Shrimp) Growth Experiment

The brine Shrimp Artemia was flown to determine the genetic effects of microgravity on cysts hatched in space. Cysts were injected into a saline solution upon experiment activation. The growing shrimp, called nauplii, were observed during the remainder of the flight with a 35mm motor-driven camera.

Surface Tension Experiment

The goal of this experiment is to study the shape of liquid meniscus in a weightless environment. An aluminum block contained several holes filled with solder. Upon entering weightlessness, the block was heated, allowing the solder to flow and assume a meniscus shape. The block was allowed to cool, "freezing" the meniuscus when the solder solidified.

Composite Curing Experiment

This experiment completed the cure of a B-staged (partially cured) epoxy resin-graphite composite sample in microgravity. The composite sample was heated to 163 degrees C and maintained at that temperature for one-half hour to allow the resin to gel.

Thermal Conductivity Experiment

The goal of the experiment was to carry oil and water into orbit and mix the two, then heat the mixture with a platinum wire. Temperatures of the heater wire, the mixture, and the air around the cylinder were monitored. Ultimately, the thermal conductivity of the mixture will be calculated from these data.

Microgravity Soldering Experiment

The Microgravity Soldering Experiment studied the separation of flux from solder while soldering in weightlessness. The experiment melted samples of resin core and coreless solder on four heated copper foils.

Root Growth of Lemna Minor L. (Duckweed) in Microgravity

Using the 35mm camera shared with an experiment described earlier, this experiment photographed the root growth patterns of Lemna Minor L. (duckweed). The investigation centered on the nutrient transport role played by sieve tubes in the plants' roots. The plants were injected with a fixing agent before experiment deactivation.

Homogeneous Alloy Experiment

An aluminum chamber containing a powdered bismuth-tin mixture was heated, passing the melting points of the chemicals and allowing alloying to take place. The chamber was cooled down and the alloy returned for Earth-based analysis.

Algal Microgravity Bioassay Experiment

The goal of the experiment was to monitor the growth rate of Chlorella vulgaris, a unicellular green algae, in microgravity. Upon experiment activation, a freeze-dried sample of algae was injected into the media-filled growth chamber. Over the duration of the experiment the culture optical density and temperature were measured. Near the end of this experiment, a fixative was injected into the chamber preserving the cells for post-flight analysis.

High School Student Experiments

Two of the medical experiments conducted on this flight of Columbia were proposed by high school students. As winners in the first annual Shuttle Student Involvement Project, (SSIP) Amy Kusske of Wilson High School, Long Beach, Cal. and Karla Hauersperger of East Mecklenburg High School, Charlotte, N.C. combined experimental test procedures to study the human body's response to weightlessness.

To get their experiments on board the Shuttle, both students entered the nationwide SSIP contest and had their proposals critically examined by scientists and educators along with hundreds of other proposals. Experiments were checked for scientific validity and interest, safety, and feasibility. Kusske and Hauersperger were two of ten finalists from the first competition. Another of the finalists, Todd Nelson, flew his experiment on Columbia's third flight in March of 1982.

Kusske's experiment is titled "The Effects of Diet, Exercise, and Zero Gravity on Lipoprotein Profiles." Lipoprotein, found in the blood, can be used to predict the likelihood of someone contracting atherosclerosis and coronary disease. (Atherosclerosis is a common form of arteriosclerosis.) To make predictions, the relative concentrations of high density and low density lipoproteins were compared. Exercise increases the ratio between the two types of lipoproteins and decreases the risk factor for contracting either disease.

During the flight, Columbia's crew kept diet and exercise logs. Blood samples of each crewmember were taken during regular physical examinations seven and two days before the flight and upon touchdown. Copies of the logs and results of the blood samples are being studied by Kusske.

Hauersperger's Experiment, "The Effects of Space Travel on Level of Trivalent Chronium in the Body" also required the daily diet logs of the crewmembers and the results of the blood samples.

Her experiment is looking at any alterations that occurred in chromium metabolism during the flight. Serum levels of insulin are known to change slightly during space flight and insulin helps control body use of carbhydrates. Chromium is a cofactor (substance which must be present in low quantities for an enzyme to work) for insulin.

To assist the two students in their experiments, corporate sponsors and NASA scientists were selected to serve as advisors.

Facts and Figures

Spacecraft: Columbia (Orbiter 102)
Crew: Thomas K. Mattingly (commander)
Henry W. Hartsfield (pilot)
Launch site: Launch Complex 39A, NASA Kennedy Space Center, Florida
Launch Date: June 27, 1982, 10:59:59 AM Eastern Daylight Time
Vehicle mass at launch: 2,033,440 kg
Payload mass (excluding DOD payload): 5440 kg
Solid Rocket Booster separation: 00:02:11 Mission Elapsed Time (MET)
Splashdown location: 78° W, 28.4° N
Main engine cutoff: 00:08:33 MET
External Tank separation: 00:08:50 MET
Orbital Maneuvering System Engines burn data:

OMS-1: 88 seconds (duration)
46.9 m/sec (velocity change)
63 × 241 km (resulting orbit)
OMS-2: 105 seconds
53.3 m/sec
241 km circular
OMS-3: 32 seconds
16 m/sec
298 × 241 km
OMS-4: 32 seconds
16 m/sec
298 km circular
OMS-5: 17 seconds
4.6 m/sec
315 × 298 km

Orbital velocity: 7,720 m/sec (near end of mission)
Orbiter inclination: 28.5°
Orbital period: 90.5 minutes (approximate)
Number of orbits: 112, landed on 113
Distance traveled in orbits: 4,701,070 km (approximate)
Deorbit retrofire: 168:10:00 MET
Touchdown time: 169:09:31 MET
9:09:31 AM Pacific Daylight Time, July 4, 1982
Landing velocity: 343 km
Landing rollout: 2945 m
Mass of Orbiter on landing: 94,930 kg

Activities and Dicussion for the Classroom

1. Research the electrolysis process for chemical separation. If possible, set up an electrolysis demonstration for the classroom. Information about setting up a demonstration can be obtained in chemistry sourcebooks.
2. Why is it important to understand the Shuttle's induced environment in space?
3. What are some of the problems and concerns in space research on living things?
4. Now that the Space Shuttle has become an operational space launch system, discuss what uses the Shuttle might be put to over the next two decades.
5. High School teachers interested in involving their students in future Student Shuttle Involvement Project competitions should write the following address:
   Shuttle Student Involvement Project
   National Science Teachers Association
   1742 Connecticut Avenue, N.W.
   Washington, DC 20009

Editor's Note: This is the last Educational Brief that will be devoted to regular flights of the Space Shuttle. Future Shuttle related Briefs in the series will concentrate on specific Shuttle payloads and missions.

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